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AUTHOR Adams, Marilyn Jager
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ABSTRACT

Skilled reading depends upon a multiplicity of perceptual, linguistic, and cognitive processes; inadequate development of one or more of these processes may in turn lead to reading difficulty. This report considers some of the processes that may be especially problematic for the young reader. After an overview in which skilled reading is described as the product of both analytic and synthetic, or bottom-up and top-down, activities, potential sources of difficulty are discussed under three general headings: word recognition, syntactic processing, and semantic processing. (AA)

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Technical Report No. 37

FAILURES TO COMPREHEND AND LEVELS OF PROCESSING IN READING

Marilyn Jager Adams

Bolt Beranek and Newman Inc.

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University of Illinois
at Urbana-Champaign
1005 West Nevada Street
Urbana, Illinois 61801

BBN Report No. 3593

Bolt Beranek and Newman Inc.
50 Moulton Street
Cambridge, Massachusetts 02138

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Reading deficiency is one of the most significant problems facing educators today. By recent estimates, as many as 40% of the school-age children in the United States may be handicapped by reading difficulties (Goldberg & Schiffman, 1972). The significance of the problem, however, is only partially reflected by such statistics, since reading difficulties may result in poor performance in other educational activities. Reading is one of the basic ways of acquiring information in our society and in academic settings in particular. The individual who cannot read well is at a serious disadvantage with respect to educational and, consequently, vocational opportunities.

Why so many children have trouble learning to read is not well understood. In some cases, mental or physical disabilities can be cited as the underlying cause. But more often, reading problems have not been clearly associated with diagnoseable mental or physical deficits. This has led to the definition of clinical syndromes such as dyslexia and minimal brain dysfunction that acknowledge and label the problem, but do not explain it.

A basic assumption of this chapter is that skilled reading depends upon a multiplicity of perceptual, linguistic, and cognitive processes and that, for many children, reading difficulties reflect the inadequate development of one or more of these processes. The purpose of the chapter is to consider some of the processes that may be especially problematic for the young

reader. The chapter begins with an overview in which skilled reading is described as the product of both analytic and synthetic, or bottom-up and top-down activities. Following this overview, potential sources of difficulties are discussed under three general topics: word recognition, syntactic processing, and semantic processing.

Overview

For the skilled reader, the processes involved in reading are so well learned and integrated that written information can flow almost automatically from sensation to meaning. As the letters of the text are identified, they simultaneously prime or set up expectations about the identities of the words to which they belong. As the words are identified, they prime the most probable syntactic and semantic structures. More generally, since the end products of each level of analysis are the elements for some other level, the information is naturally propagated upwards through the system, through increasingly comprehensive levels of analysis. This is called bottom-up processing. While all of this is happening, the partially activated candidates at each level are competing for completion; as they do so, they reciprocally prime or facilitate the processing of their missing elements. This is called top-down processing. For the skilled reader, top-down and bottom-up processing are occurring at all levels of analysis simultaneously as he proceeds through the

text. He is therefore able to make optimal use of the information on the page, the redundancy of the language, and the contextual environment with minimal effort. The top-down processes ensure that the reader will easily assimilate lower order information that is consistent with his expectations, as it will already have been partially processed. Meanwhile, the bottom-up processes ensure that he will be sensitive to any information that is novel or that does not fit his on-going hypotheses about the content of the text. (For a more thorough description of the reading process, see Rumelhart's chapter in this book, or Adams & Collins, 1977.)

The efficient operation of such a system depends as much on the information in the reader's mind as on the information in the written text. If the reader is lacking any critical skill or piece of knowledge, the flow of information through the system will be obstructed. In these cases, the reader must find a way to compensate. One of his options is to direct extra processing energy to the difficulty until it is resolved; for example, he may pause and articulate a difficult word. Alternatively, he may rely on top-down processes to evade the problem; for example, he may use contextual information to infer the meaning of an unfamiliar word. Both of these solutions are normal and adaptive and are regularly used by skilled readers. Thus, one kind of difficulty that we might expect of the beginning reader is that

ne might fail to adopt either of these strategies. However, equally serious problems might arise if he adopts either of these strategies to the extreme.

The danger of relying too heavily on top-down processing is obvious. The proper balance between the information that the reader should bring to the text and that which the text should bring to the reader will be lost. To the extent that guesses are based on prior guesses, the individual is not really reading in any useful way. Yet, for the beginner, some of the most basic aspects of reading, like letter and word identification, are also the most foreign. By contrast, he already has a wealth of linguistic and real-world knowledge, and in terms of content, his required reading materials are probably quite simple. He may, therefore, find that he can often guess the identity of a word as accurately and more easily than he can, for example, sound it out. It would not be surprising, then, to find beginning readers who have learned to depend on this strategy.

In the long run, the alternative strategy of focusing one's attention on the difficulty may be more adaptive. At least it provides an opportunity for learning. The danger in using this strategy is that comprehension may consequently suffer. The problem is that the human mind is a limited capacity processor. As LaBerge and Samuels (1974) have pointed out, the reader can selectively direct his attention to any particular subprocess,

but only by taking it away from deeper levels of analysis. In G. Stanley Hall's words, true reading only occurs "...when the art has become so secondarily automatic that it can be forgotten and attention be given solely to the subject matter. Its assimilation is true reading and all else is only the whir of the machinery and not the work it does" (1911, p. 134).

The problem of limited processing capacity is especially critical for the young reader. First, many of the necessary subskills are not well learned and, therefore, demand considerable attention. Second, the functional memory capacity of the young child tends to be less than that of the adult. It is not entirely clear why this is so: some have argued that the span itself increases with age (e.g., Farnham-Diggory, 1972); some have attributed it to young children's failure to "chunk" or organize the material for efficient storage (e.g., Flavell, 1970; Olson, 1973; Simon, 1974); still others have argued that it only reflects the differential effort that children must invest in the encoding of to-be-remembered items (e.g., Huttenlocher & Burke, 1976). Regardless of which explanation is correct, the important implication for the present discussion is that processing capacity is least yielding at the point when task demands are highest.

Craik and Lockhart (1972) have cited two other factors that may divert attention from meaningful levels of analysis. The

first of these is the nature of the material to be encoded; unless it is potentially meaningful, processing will naturally stop at structural levels of analysis. Although Craik and Lockhart were specifically concerned with the appropriateness of digit lists and the like as stimuli in memory tasks, the point is easily extended to the reading situation. Materials intended to support comprehension in beginning texts must be chosen with careful consideration of the knowledge and interests of their young readers. The second factor cited by Craik and Lockhart is the nature of the ostensible task demands. If the encoder is instructed to focus on nonmeaningful aspects of a stimulus, he will do so. A major criticism of the instructional programs that emphasize the mechanics of reading is that they may effectively teach the reader to ignore semantic dimensions of the text.

Again, true reading is only possible if the whole complex of subprocesses are functioning easily and in proper coordination. None of the processes can be absent or require undue attention, or comprehension will suffer. For the skilled reader, difficulties will be few and far between; when they do arise, he will probably find an effective way to overcome them. By contrast, the beginning reader will frequently encounter difficulties. His first challenge is to discover ways to overcome them; his second is to learn how to do so without forfeiting the meaning of the text. The remainder of this

chapter will focus on specific problems that might beset the beginning reader and the ways in which these might affect his reading comprehension.

Word Recognition

Many of the components of the reading process are not new to the beginning reader. From his oral language experience, he has already acquired a substantial vocabulary and basic syntactic competence. He is used to making sense out of language and has a wealth of real-world knowledge to draw on in this effort. He may even have some appreciation of what reading is all about. What he is most flagrantly lacking is the ability to decipher the written word.

It is not surprising, therefore, that early reading instruction is concentrated on word recognition skills. Despite this, reading difficulties are often traceable to deficits at the level of word recognition. For example, Perfetti and Hogaboam (1975) have shown that more skilled comprehenders can name a printed word faster than less skilled comprehenders, and that this advantage is especially marked with less frequent or unfamiliar words. Further, poor readers have been found to rely heavily on the initial letters of words, ignoring or failing to synthesize the cues from medial or final portions (Rayner & Hagelberg, 1975; Shankweiler & Liberman, 1972), to be less

sensitive than good readers to the spatial redundancy of English orthography (Mason, 1975), and to be less facile with the spelling-to-sound correspondences of English (Jorm, 1977; Venezky, 1976).

The ability to recognize single written words is, in itself, a very complicated skill. That we do not fully understand it is evidenced by the hundreds of theoretical and experimental papers on the topic; that we do not know how best to teach it is evidenced by the hundreds of early reading programs which purport to do so. Inasmuch as letters were not designed for maximal discriminability, letter recognition presupposes a fair amount of perceptual learning (Gibson & Levin, 1975). Moreover, the ability to recognize single letters is many steps removed from the ability to recognize printed words, and there are many conflicting ideas about how these skill levels should be introduced and integrated.

A long-standing controversy in this vein is whether instruction should be focussed on letter-to-sound correspondences or whole words. The major advantage of whole word approaches is that they provide a more direct path from symbol to meaning. Thus, whole word approaches may make the task of learning to recognize words more interesting for the beginner, and they may also make it easier: whereas young children have little difficulty in learning to associate arbitrary visual patterns

with meaningful, familiar responses, they have great difficulty in learning to associate such patterns with individual speech sounds or nonsense syllables (Venezky, 1976). Further, many children have trouble relating individual speech sounds to syllables or whole words (Savin, 1972; Wallach, Wallach, Dozier, & Kaplan, 1977).

But even if whole words are initially easier to learn, children who have been taught to read without due emphasis on the mechanics of decoding are found to be at a disadvantage in the long run (Barr, 1975; Chall, 1967). Venezky and Massaro (1976) have argued that the most important component of letter-to-sound instruction is that it directs the child's attention to frequent spelling patterns. Orthographic regularity has a strong influence on the ease with which skilled readers can encode a string of letters (Baron & Thurstone, 1973; Gibson, Pick, Osser, & Hammond, 1962; Mewhort, 1974; McClelland, 1976). However, such sensitivity to orthographic regularity develops only gradually through years of reading experience. For the less skilled reader, a more immediate benefit of instruction in letter-to-sound correspondences is that they provide a means by which he can identify words that are in his listening vocabulary but are visually unfamiliar.

Since the beginning reader is bound to encounter many visually unfamiliar words, we should consider what is involved in

sounding them out. First, the reader must parse the letter string into sets of one or more letters which correspond to phonemic units. Notably, there may be more than one apparent way to do this (e.g., nowhere vs. nowhere). In addition, he must look for graphemic markers, like final e's, that might modify the phonemic significance of any of these sets. Next, he must generate the sounds corresponding to each graphemic set. Even if he has correctly segmented the graphemic string, this process may depend on trial and error since a graphemic set may signify more than one pronunciation (e.g., through vs. rough). Moreover, to do the job right, he cannot focus exclusively on one graphemic set at a time; the pronunciation of a graphemic unit may vary with both its position in the word (e.g., ghost vs. rough) and its graphemic environment (e.g., city vs. call). Next, these sounds must be blended together, and this, in itself, may be hard for some children (Savin, 1972). Having thus translated the printed word into a spoken correspondent, the reader must check to see that the result makes sense in the larger context of the sentence. If not, he must reiterate.

In short, the process of sounding out a word can be very complicated. Since mere vocalization of a word may absorb a substantial proportion of the young child's processing capacity (Conrad, 1972), the additional load imposed by decoding must push the capacity to its limits. Evidence for this conjecture occurs

repeatedly in MacKinnon's (1959) observational study of beginning readers. Although many of the children in his study could successfully sound out new words, they tended, as a consequence, to block on previously familiar words in the sentence.

Further, if the child must focus his attention on the structural properties of words, he may lose the meaningful dimensions of the passage (Craik & Lockhart, 1972; LaBerge & Samuels, 1974). Jenkins and his colleagues (see Jenkins, 1974, for a review) have demonstrated this effect with adults through free recall studies. If, during list presentation, subjects are asked to perform semantic orienting tasks on the items (such as rating them for pleasantness or activity, estimating their frequency, or generating semantically appropriate syntagmatic responses), their associative clustering and total recall scores are at least as good as those of subjects who are simply and explicitly instructed to memorize the lists. By contrast, subjects who are instructed to focus on orthographic, phonetic, or syntactic aspects of the items during presentation, show little clustering and poor recall. Apparently, high levels of recall in this task depend on the subject's having interrelated semantic attributes of the items. When attention is focused on nonmeaningful dimensions of the stimuli, retention suffers as semantic organization is preempted. In keeping with this, nonsemantic orienting tasks have been shown to exert similarly

deleterous effects on the retention and comprehension of meaningful sentences (Rosenberg & Schiller, 1971; Till, Cormak, & Prince, 1977).

Perfetti (1975) has provided more direct evidence that reading comprehension may suffer as the result of devoting too much attention to decoding activities. The children in his study were periodically interrupted by a memory probe as they read a passage to themselves. When reading silently, the poor decoders tended to have better memory than the good decoders for words that immediately preceded the probe. This would be expected if the poor decoders were paying more attention to individual words. As would also be expected in this case, the poor decoders' memory for words that were only slightly more distant from the probe was substantially worse than the good decoders'.

Strong attention to decoding should pay off in the long run as the reader becomes familiar with more and more words. In the meantime, however, it will detract from more meaningful levels of analysis. Further, the reading difficulty of a laborious decoder may well be misdiagnosed. If his efforts are successful, he may appear to be having little difficulty with individual words. The only symptoms may be that he is not remembering or comprehending, and perhaps that he is reading in a word by word manner. But these same symptoms may alternatively reflect syntactic or semantic difficulties.

The other means of coping with visually unfamiliar words is that of using the syntactic and semantic constraints of the text to guess their identity. In this way, processing at higher levels may compensate for decoding difficulties. As was argued in the introduction, this is a normal aspect of skilled reading, and recent studies suggest that even for young children, reading is, in part, a generative, top-down process. For example, Perfetti (1975) has demonstrated that children's ability to read a word is facilitated almost as much by their having heard the word before as by their having heard and seen it before. Weber (1970) has shown that the substitution errors of first graders during oral reading are more strongly controlled by the syntactic and semantic contraints of the text than by the graphemic cues of the mistaken words. And Wittrock, Marks, and Doctorow (1975) have shown that children are better able to process unfamiliar words if they are embedded in a familiar as opposed to an unfamiliar story.

Biemiller (1970) tracked oral reading errors longitudinally through the first grade. Like Weber, he found that the majority of his subjects' reading errors consisted in a substitution of the correct word with an alternative that was semantically and syntactically acceptable within the sentence. However, he further found that the proportion of substitutions that were graphemically similar to the correct word, increased towards the

end of the year. This study provides a strong rationale for the initial emphasis on decoding skills. Apparently, beginning readers find it easier to guess at the identity of an unfamiliar word than to decode it. Inasmuch as this strategy seems to work quite well for simple beginning texts, there may be little incentive for the development of decoding skills. However, when the child is advanced to more complex and less constrained reading material, decoding skills must be well developed since guessing will not suffice. Top-down processing clearly changes from a help to a hindrance when it is used to avoid decoding altogether.

Kolers (1975) has recently presented evidence that such use of top-down processing to avoid decoding may be a fairly common source of reading difficulty among older children. In his experiment, good and poor readers between the ages of 10 and 14 years were presented with sentences in normal and reversed type. When the sentences were read aloud, the substitution errors of both good and poor readers were, in general, grammatically appropriate. But the poor readers made almost ten times as many substitution errors as the good readers. In addition, the poor readers were relatively insensitive to graphemic or typographic aspects of the stimuli. Whereas the number of letters in the substitution responses of the good readers was highly correlated with the number in the printed word, the number of letters in the

substitution responses of the poor readers was not. Although the poor readers read the normally typed sentences more slowly than the good readers, their reading speeds were less affected by the reversed typography than were those of the good readers. Finally, recognition scores indicated that the poor readers remembered the typography of the stimuli less well than did the good readers. In short, among Koler's subjects, poor reading was coupled with frequent guessing and relatively little attention to the typographic and graphemic aspects of the stimuli; taken together, these symptoms clearly indicate an overreliance on top-down processing.

In summary, the reader can cope with visually unfamiliar words through either top-down or bottom-up processes. Although both types of processes are important, neither is satisfactory by itself. For the skilled reader, top-down and bottom-up processes operate as complements rather than substitutes for one another. But this can only happen when the processes involved in word recognition have become sufficiently overlearned that they require minimal effort.

Syntactic Processing

While word recognition is a necessary component of language comprehension, it is not sufficient. The meanings of individual words are diffuse and ambiguous. In discourse, they become

defined only as they are interrelated to one another. In large part, the intended meaning of a word may be defined by its semantic intersection with other concepts in the context (Quillian, 1969). Just as "a good play" will be interpreted differently in a theater than a ballpark, "ball" will be interpreted differently if it is preceded by "soccer" rather than "inaugural." But the intersections between meanings are not always enough, as shown by the difference between "play the horses" and "the horses play" or "John was kicked by Mary" and "John kicked Mary." Syntax is the primary means by which we can specify the intended relation among words. Thus, syntax subserves communication not only by disambiguating the referents of the words but also by defining new relations among them. It is clear that syntactic competence is an important dimension of linguistic competence in general. The question to be addressed in this section is whether there are aspects of syntactic processing that are peculiar to the domain of reading.

The traditional emphasis on decoding skills in reading instruction derives from the view that written language is no more than ciphered speech. According to this view, if the child can learn to break the code -- to translate the letters into their corresponding sounds -- then the problem of reading is solved. The remainder of the task simply requires the application of previously acquired aural/oral language skills to

the deciphered text. Given the prevalence of this argument, the paucity of studies on the role of syntactic processes in reading probably should not be surprising.

But the validity of this argument rests on two highly suspect assumptions. The first of these is that the beginning reader is only lacking in decoding skills -- that if he could recognize the words, he has the linguistic competence to realize the meaning of the text. The second is that the processes which he uses in the interpretation of spoken strings of words are adequate and appropriate for the interpretation of written strings of words.

The assumption that the beginning reader lacks only decoding skills has been bolstered by the common assertion that children are linguistically mature by the time they get to elementary school. However, as Palermo and Molfese (1972) have pointed out, this is an overstatement: children continue to demonstrate substantial gains in their ability to understand syntactic structures until they are at least thirteen years old. Apparently the more popular view evolved from the observation by developmental psycholinguists that all of the basic syntactic transformations which, according to Chomsky's (1965) theory of generative grammar, underlie adult sentence structures can be found in the utterances of many children by the time they are four or five years old (Brown, 1965; Menyuk, 1963). This is very

different from saying that young children can produce sentences of the same syntactic complexity as an adult can. Even so, those who believed in transformational grammar argued that a working knowledge of all of the basic transformations is formally equivalent to basic syntactic competence; if young children cannot produce sentences of arbitrary complexity, it must be primarily due to factors constraining performance, like memory limitations (McNeill, 1966). The data and the argument were inevitably condensed into such statements as that "[children] acquire syntax almost completely at 48 to 60 months" (McNeill, 1970, p. 1062) or that by four of five years of age, children have succeeded "...in mastering the exceedingly complex structure of [their] native language" (Slobin, 1971, p. 1). These statements were meant to provoke interest in the remarkable language accomplishments of very young children; as an unfortunate side effect, they may have discouraged interest in syntactic development in older children.

Whatever the status of a child's syntactic competence, decoding difficulties aside, shouldn't he be able to understand any written sentence that he would be able to understand if it were spoken? Not necessarily. The child probably needs relatively little syntactic sophistication to understand most of what is said to him. The interpretation of any utterance may be strongly guided by its real-world context and the tone and stress

patterns of the speaker. Typically none of these cues are present in written language. To the extent that the child has only the words and their interrelationships to work with, syntactic competence is critical for reading.

Suppose that a child does have the syntactic competence to interpret a given sentence structure in spoken discourse. Can we then assume that he could understand it if he read it? Again, the answer is no. In speech, syntactic boundaries are marked by prosodic cues. When speaking fluently, people tend to restrict pauses and breaths to syntactic boundaries (Henderson, Goldman-Eisler, and Skarbek, 1965; 1966). In addition, the durations of the spoken elements themselves vary reliably with the phrase structure of the utterance (Huggins, 1974; Klatt, 1975). Apparently, the listener depends on these temporal cues; when they are distorted, comprehension falls precipitously (Huggins, in press). Except for punctuation marks, written discourse provides no such cues. The segregation of phrasal and clausal units is left largely to the reader. The implication is again that reading presumes a level of syntactic proficiency that is not required for listening.

In view of the above, we may conclude that the processing differences between reading and listening do indeed extend beyond the level of word recognition. First, reading demands more syntactic sophistication than does listening. Second, whereas

the syntactic structure of a spoken sentence is largely given to the listener through prosodic cues, the syntactic structure of a written sentence must, in large part, be discovered by the reader. Unless the reader can recover or construct the syntactic structure of the printed sentence, it doesn't matter whether he has the syntactic competence to understand it.

For skilled readers, the recognition of syntactic units is so automatic that it has become an integral part of the input process itself. Cattell (1886) found that when whole phrases or short sentences are tachistoscopically presented, skilled readers tend to recognize them completely or not at all. Similarly, skilled readers tend to encode connected discourse in phrasal units; if the text is abruptly removed, their "reading" typically does not stop until a phrasal boundary has been reached (Levin and Kaplan, 1970; Schlesinger, 1969). Thus, not only can skilled readers take in whole phrases at a glance, but their glances are apparently programmed to do so.

How is the reader able to coordinate his visual fixations with the phrase structure of the text? Somehow he must be able to anticipate the upcoming syntactic units when he plans his fixations. One possible explanation for this phenomenon is that the reader's fixations are determined by graphical information gleaned from the peripheral visual field. Yet, peripheral acuity is quite poor. Only the one or two words within one or two

degrees of visual angle from his fixation point are fully legible. A little further into the periphery, he can only discern the initial and final letters and the gross shape of the words (Rayner, 1975). A little further still, only word length cues are available (McConkie, 1976). Since short words are often functors (e.g., in, on, of, to) which introduce phrases, word length cues may exert an important influence on eye movements (Hochberg, 1970). Given the impoverished nature of the peripheral visual cues, an equally plausible explanation is that the reader's fixations are primarily controlled by his hypotheses about what he is about to read. In keeping with this, the amount of information a person can recite after the text is taken away, increases with the syntactic and semantic predictability of the passage (Lawson, 1961; Morton, 1964a, 1964b).

Marcel (1974) has recently provided evidence that both of these explanations are correct. In Marcel's experiments, subjects were presented with two successive strings of words. They were allowed to study the first string for as long as they wanted; its purpose was to provide a context for the second string. The second string was presented for only 200 milliseconds and therefore could be fixated only once. The subjects' task was to report as much information as they could from the second sequence of words. Marcel found that the amount of reported information increased with the semantic and syntactic

constraints of the sequences. In order to discover the reason for this increase, Marcel analyzed the errors. In support of both of the hypotheses described above, almost all of the subjects' erroneous responses were either visually or grammatically comparable to the presented word. With increasing contextual constraint, the balance tipped slightly toward grammatically acceptable substitutes, as might be expected. But Marcel's most exciting finding was that increased contextual constraint led to a disproportionate increase in the number of errors that were simultaneously grammatically and visually acceptable; thus, it apparently increased the visual angle at which the subjects could discern graphical details of the printed information. This is a compelling demonstration of interfacilitation between top-down and bottom-up processes.

The importance of parsing the sentence on input relates back to the fact that the human mind is a limited capacity processor. If an unstructured string of words were presented to an individual at the rate of normal reading, he would lose track after four or five words: his active memory capacity would be exceeded (Miller, 1956). When we are reading or listening to connected discourse, we get around this problem by recoding the information at syntactic boundaries (Fodor, Bever, and Garrett, 1974; Jarvella, 1971; Kleiman, 1975).

For the reading situation, Kleiman (1975) has specified the process most completely. According to his model, as the reader proceeds through the text, he enters each word into his short-term memory buffer. After each word is entered, the reader checks to see whether or not it completes a constituent structure. If not, he proceeds to the next word. As soon as he thinks he has a completed phrase, the contents of the buffer are recoded or collapsed into a composite meaning complex. At this point he checks to see whether the sentence has been completed. If it has not, he starts working on the words of the next syntactic unit. If it has, the contents of the short-term buffer are transferred to long-term memory, and he is ready for a clean start on the next sentence. (A parallel model for aurally presented text has been proposed by Jarvella, 1971.)

If Kleiman's model is correct, then it underscores the importance of correctly isolating syntactic constituents during input. If the reader recodes after each individual word, then he will miss their interrelationships and, consequently, the meaning of the sentence as a whole. If the reader does not segment the sentence at all, then he is liable to overload his short-term buffer. As a result, some of the words will be lost, and comprehension will suffer. If the reader incorrectly analyzes the sentence, then the recoded meaning-complexes will misrepresent the text and may even be anomalous.

To the extent that the processes and even the necessity of actively identifying the syntactic units of a sentence are unique to reading, we might expect them to be troublesome for the beginner. Indeed, beginning readers do not sample written material in phrasal units (Levin and Kaplan, 1970). They indulge in many more fixations per line of text than do mature readers (Kolers, 1976). In part, this is probably because they must devote more attention to the reading of individual words. In part, it is probably because such cues as word length, word shape, and terminal letters become useful only with considerable reading experience. But some children may fail to recognize the surface structure of a sentence during encoding only because they don't know how to or because they haven't figured out that they are supposed to.

In keeping with this, several studies have shown that good readers are more sensitive to syntactic structure per se than are poor readers. For example, Cohen and Freeman (in press, p. 8) found that, when reading fourth order approximations to English aloud, "good readers struggled to impose an intonation pattern on the material, segmenting it into phrase-like units. Poor readers read in a monotone as if it were a word list." Weinstein and Rabinovitch (1971) investigated the effect of syntactic structure on good and poor readers' memory for sentences like Zalfly they when, veg the hanashed, sivoled they versus When they sivoled the

veg, they hanashed zalfly. Differences in decoding abilities were controlled by presenting the sentences aurally. Whereas the good readers performed better with the well structured materials, the poor readers did not, and the two groups performed equally poorly with the unstructured strings.

One might question the pertinence of studies using nonsense materials. As Huggins points out in his chapter in this book, semantic variables normally contribute heavily to syntactic processing. But semantic cues are not always sufficient. Using meaningful materials, Cromer (1970) has shown that the reading comprehension of some poor readers can be improved by superficially demarcating phrasal boundaries. Even skilled readers may benefit from superficial syntactic cues given a complex structure; Fodor and Garrett (1967) have shown that embedded sentences, like The girl (that) the boy (that) the man knew saw left, are easier to understand if the "that's" are included. Conversely, if the structure of a sentence is obscured or distorted, good readers are less able to understand or remember it (Anglin & Miller, 1968; Oaken, Wiener, & Cromer, 1971).

Weaver (1977) has recently completed a very encouraging study on the trainability of syntactic sensitivity. In her study, third grade readers were given series of individual tutorials on solving sentence anagrams. The tutorials were

designed to induce the children, first, to pick out phrases and clauses from the scrambled words, and then to arrange the phrases and clauses into meaningful, complete sentences. More specifically, the children were taught to look for an "action" word first and then to ask a series of "wh" questions so as to group the remaining words into phrases and clauses and determine how they were related to the verb. Thus, the procedure implicitly required the children to attend both to word order and to different parts of speech (cases) and the syntactic devices by which they are signalled. The training procedures resulted not only in an improvement in the children's unassisted ability to solve sentence anagrams, but also in an improvement in their performance on several other tests of reading comprehension and memory.

To summarize this section, reading requires a syntactic awareness that is generally not required for listening. If the reader does not have the necessary competence to organize written material into syntactic constituents, both comprehension and memory for the material will suffer. Syntactic difficulties may be peculiarly treacherous. In a child's first textbooks, the sentences are simple and may even be presented on separate lines of print. Thus, at this stage, when teachers are concentrating on reading skills, he may experience no difficulties. Yet, later when he must manage more complex texts--when he is supposed to be

reading to learn rather than learning to read--his problems may be overwhelming. Moreover, such problems may be difficult to either detect or correct. If a reader cannot recognize a word, he knows he cannot. If he cannot correctly recognize a syntactic structure, he may not even realize it. Further, at the lexical level, it is easy to distinguish between whether the reader does not know a word or just can't read it. The parallel distinction at the syntactic level may be unclear.

Semantic Processing

The meaning of a text is in the mind of the reader. The text itself consists only of instructions for the reader as to how to retrieve or construct that meaning. The words of a text evoke in the reader, concepts, their past interrelationships and their potential interrelationships as defined by their semantic properties. The syntactic structures of a text help the reader to select among these conceptual conglomerates. In order to understand a written text, the reader must therefore be able to recognize the words and to analyze the syntax. But he must also be able to access and organize the appropriate conceptual knowledge, and this depends on a variety of semantic knowledge and processes.

At a gross level of analysis, there are two classes of difficulties that might beset the reader at the semantic level. The first class of difficulties has to do with the fidelity or completeness with which the reader can map the intended meaning of the textual elements onto his own conceptual structures. The second class of difficulties has to do with the reader's ability to usefully organize the meaning of the passage. Many of the specific issues subsumed by these categories are discussed in detail elsewhere in this book. The purpose of the present section is to illustrate, at a categorical level, their particular relevance to the young reader.

Beyond general naivety, there are many kinds of problems that may impede the mapping process for the young reader. Among those discussed in the chapters to follow are: a lack of appreciation of pragmatic dimensions of discourse (Bruce); differences between the dialects of the child's reading materials and his oral language environment (Hall); difficulties in coordinating references (Nash-Webber); difficulties with polysemy, metaphor, and figurative language (Ortony); and difficulties in appropriately altering his point of view (Rubin). The point to be made here is that any of these difficulties could arise from either of two sources. On one hand, the child may have the conceptual knowledge to understand the meaning of the text, but be unfamiliar with the words or linguistic devices by

which it is expressed. Alternatively, he may lack the concepts signified by the text. Furthermore, these two sources are not independent, as the child's linguistic sophistication is bounded by his conceptual sophistication.

This point is illustrated with the problem of insufficient vocabulary. This is a common problem for young readers, and one that may reflect nothing more than a lack of linguistic experience. As an example, Bradshaw and Anderson (1968) traced the development of nine adverbial modifiers from first grade through adulthood. The modifiers were: slightly, somewhat, rather, pretty, quite, decidedly, unusually, very, and extremely, and they were used to modify the word large. The children's differentiation of the meanings of these modifiers was tested through a paired-comparison procedure. Bradshaw and Anderson found that for the youngest children the meanings of slightly and somewhat were neutral or perhaps empty; not until fourth grade in the case of the former and eighth grade in the case of the latter, was the minimizing impact of these modifiers realized. Similarly, extremely was not regularly interpreted as signifying more than very until fifth grade. It seems unlikely that children's ability to conceptualize relative differences in quantity would develop so unevenly. Rather, the most plausible interpretation of these results is that the differences in the meanings of these words are subtle and the semantic elaboration

that is necessary to distinguish between them is only picked up through considerable experience. Meanwhile, the child's understanding of sentences using these words will be impoverished.

Indeed, vocabulary is the single best predictor of a child's ability to comprehend written material (see Rosenshine's chapter on skills hierarchies and taxonomies). But this is only partly because a bigger vocabulary means fewer word comprehension failures. There are at least two, more important reasons for this correlation. First, both vocabulary and reading comprehension skills must depend on the quantity and quality of the child's general linguistic experience. Second, some vocabulary difficulties may be rooted in conceptual deficiencies since the meaningful acquisition of a word presumes an understanding of the concepts to which it refers (Nelson, 1974).

The order in which words come to be understood by a child reflects the relative complexity of their underlying meanings. To demonstrate this, Gentner (1975) asked children between the ages of three and eight to make dolls act out the verbs: give, take, buy, sell, trade, pay, and spend (money). According to Gentner's analysis, the meanings of give and take were the simplest: something is transferred from one person to another. The meanings of buy and sell were supposed to be the most

complex: something is transferred from one person to another and some money is transferred in exchange. Consistent with this, only give and take were reliably understood by the youngest subjects. The full meanings of the others were mastered in the expected order. For the eight year olds, only sell presented difficulties. Moreover, the children's performance indicated that before the more complex words were mastered, their interpretations were not wrong, but incomplete. For example, buy was most frequently misinterpreted as take, sell as give, and trade as a one-way transfer in either direction. The suggestion is that the meanings of the simpler words are fundamental to the whole set; the meanings of the more complex words develop from them through layers of semantic elaboration. Thus, the meanings of complex words effectively contain the meanings of simpler ones within their family. It is interesting from this perspective, that age of acquisition rivals frequency as a predictor of a word's accessibility (Carroll & White, 1973; Loftus & Suppes, 1973). More to the point of the present discussion, a child's understanding of a rare word implies his understanding of a host of related but simpler concepts. The utility of vocabulary tests is, therefore, not just that they provide an estimate of the number of words that a child can recognize and understand; in addition, they provide a rough index of his conceptual sophistication.

Sinclair-de-Zwart (1969) has shown that the acquisition of syntactic structures may also depend on the child's level of cognitive development. In her experiment, children were first tested for their understanding of conservation of quantity, or, in other words, for their appreciation of the fact that excesses on one dimension may compensate for shortages on another. They were then asked to verbally compare objects that differed on two quantitative dimensions -- for example, to describe the difference between a short, fat pencil and a long, thin pencil. All of the children who had clearly demonstrated conservation used different terms to describe the different dimensions (e.g., "short" vs. "thin" and "long" vs. "fat"), and 80% of them described the objects contrastively (e.g., "this pencil is longer but thinner; the other is shorter but fatter"). Of the children who had not demonstrated conservation, 75% did not differentially describe the two dimensions (e.g., they used "big" in reference to both length and diameter). Further, 90% of the nonconservers did not use the contrastive structure: they either compared the dimensions sequentially or ignored one of them altogether. To dispel the argument that the children's language was controlling their ability to conserve rather than vice-versa, Sinclair-de-Zwart tried to teach the nonconservers how to describe the difference between the objects with the contrastive construction. She found that very few of them could learn to do so, and that those who did, generally failed the conservation post-test anyhow.

Moreover, a remarkably close temporal correlation between the development of related logical and linguistic skills is often observed (c.f., Olson, 1970; Palermo & Molfese, 1972; Taplin, Staudenmeyer & Taddonio, 1974). Almost certainly, this is not mere coincidence. It would seem more likely that the emergence of both kinds of skills presupposes the acquisition of some common conceptual structures. If this is true, then the trick for the educator is to figure out, at each point in time, which semantic distinctions can be usefully taught and which should be postponed until the child is conceptually more mature.

The second class of semantic problems has to do with the reader's ability to organize the concepts of the text into a coherent structure. Many of the issues within this category are discussed in detail in the chapters on comprehension strategies and facilitators. The importance of this kind of organization has been experimentally demonstrated: when the thematic structure of a passage is obscured or confused, both comprehension of and memory for the passage plummet (Bransford & Johnson, 1973; Bransford & McCarrell, 1974; Frase, 1972).

In order to comprehend a passage as a whole, the reader must be sensitive to the relative importance of its various concepts. The central ideas of the text will then be placed at the foundation of his own reconstruction of the meaning of the discourse. Less important ideas will be successively added in

proper relation to the central theme; irrelevant or superfluous information may be discarded; and extralinguistic information will be added as necessary to complete the structure. Adults' recall of connected discourse shows strong evidence of this sort of ideational scaffolding (Johnson, 1970; Bransford & McCarrell, 1974; Dooling & Lachman, 1971; Spiro, 1976), and Brown and Smiley (1977) have found that the same organizational tendency exists among young readers. However, Smiley, Oakley, Worthen, Campione, and Brown (1977) have recently demonstrated that sensitivity to gradations in the importance of ideational units is quite poor among beginning readers and increases only gradually with reading experience. Further, they found the same sort of insensitivity among older children who were poor readers. Smiley et al's results cannot be attributed to the confounding of lower order processes since they obtained in both reading and listening conditions.

If we could teach these children to recognize the relative importance of the ideas in a discourse, their ability to comprehend would necessarily be improved. To this end, several investigators have tried highlighting the important units by means extrinsic to the text itself. As one example, Hershberger and Terry (1965) tried to guide readers' attention by printing the essential concepts of the text in red; in the same vein, Rothkopf (1972) has studied the utility of adjunct questioning.

These techniques work in the sense that readers do tend to remember the highlighted information better. However, there is some question as to how effectively such experiences will transfer to new texts and tasks. An alternative tack is suggested by Meyer's (1975) discovery of certain structural and stylistic features that correlate with the thematic significance of the units in a text; perhaps it would be fruitful to point these out to the young reader. But again, there is some question as to how well such clues will generalize across reading situations.

The real problem in this effort is that there are few general rules by which we can identify important units of meaning across all reading situations. The ability of the skilled reader to focus on important units must pivot on his expectations about the message and structure of the passage. The optimal reading strategy will depend partly on the general nature of the passage--that is, on whether it is a political essay, an algebra problem, an allegory, a contract, or a game instruction; it will depend partly on aspects of the particular passage, regardless of its rhetorical category; and it will depend partly on the reader's reasons for reading it (Frederiksen, 1975). Thus, the most important ingredient of teaching a child to read at this level may be that of exposing him to a variety of different kinds of texts and a variety of reading goals so that he can develop a

useful variety of analytic strategies. But this must be coupled with an effort to teach him to select and implement these strategies on his own. Somehow he must acquire the notion that reading is a thinking game--that he should always try to figure out what he is looking for as he reads a passage.

The problems discussed in this section will affect not only reading but language comprehension in general. But if such problems exist, they will be magnified in the reading situation, especially when the texts become more complex and informative. In listening situations, the child's comprehension will be guided by the real-world context. In reading, there is only the text itself. The presence of pictures may help, but there is some controversy as to how much (Gibson & Levin, 1975). The reading material in primers is typically based on simple, stereotyped schemata so that semantic difficulties will be minimized. However, the content of more advanced texts will shift away from information that the child can retrieve and towards information that he must construct. Thus, semantic processing demands will increase and, at the same time, the child will be less able to check his interpretations against things he already knows.

Difficulties in comprehending spoken discourse are also much easier to overcome. First, the perceptive speaker will often be able to tell when the listener doesn't understand; he can, therefore, try to clarify the message as he goes along. Second,

if the listener doesn't understand something that is said to him, he can usually ask questions of the speaker. Since written texts are not nearly so accommodating, the reader must develop strategies for recognizing and overcoming semantic difficulties on his own. There is, after all, little point in reading without comprehending.

Summary

Skilled reading depends on a host of perceptual, linguistic, and cognitive processes. The importance of each of these processes must be defined not only in terms of the work for which it is directly responsible, but also in terms of the support it must lend to other, higher and lower level processes in the system. Thus, deficiencies in any of the requisite processes or in their coordination may result in profound difficulties for the reader. Although the beginning reader comes equipped with many of these skills as the result of his oral language experience, there are also, at each level of analysis, certain interpretive processes that are unique to reading. The purpose of this chapter was to describe some of these processes and the ways in which deficiencies in them affect reading comprehension.

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